DOCUMENT RESUME

ED 139 044 CS 203 454

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TITLE Child Language Development in Two Socio-Economic Environments.
PUB DATE Apr 77
NOTE 28p.; Paper presented at the Annual Meeting of the American Educational Research Association (New York City, April 4-8, 1977)

EDRS PRICE MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS Child Language; *Cognitive Development; Grade 6; Intermediate Grades; *Language Development; *Language Research; Science Education; *Socioeconomic Influences; Syntax; *Written Language
IDENTIFIERS *Hypothesis Formation

ABSTRACT

This study examined the relationships between cognitive development, language acquisition, and socioeconomic class, as manifested in children's written language. Four classes of sixth-grade students participated in the investigation, a control class and an experimental class from each of two socioeconomic environments (low and high). The treatment consisted of 12 science-inquiry films and six discussion sessions, during which children were taught to generate hypotheses of higher quality. At the end of each film session the students wrote as many hypotheses as they could in a rigorously controlled 12-minute period. Students in the control group responded to three additional film sessions. The collected papers were scored for hypothesis quality and syntactic complexity. Results indicated that socioeconomic level was not a variable in the relationship between syntactic complexity and hypothesis quality; scores for these two variables were positively correlated for control and treatment groups at each sociceconomic level. Both hypothesis quality and syntactic complexity were higher for the groups given instruction in the formation of hypotheses. Tables of findings are included. (AA)

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CHILD LANGUAGE DEVELOPMENT

IN

TWO SOCIO-ECONOMIC ENVIRONMENTS

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Paper presented at the annual meeting of the
American Educational Research Association, April 4-8.

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CHILD LANGUAGE DEVELOPMENT IN TWO SOCIO-ECONOMIC ENVIRONMENTS

1.0 Introduction

During the 1960's and 1970's a growing body of literature has reported on the acquisition of language by children, research studies that in large measure have focused on the acquisition of specific structural aspects of language subsystems. Brown (1970), for example, focuses on the acquisition of a selected set of grammatical morphemes by young children. Bloom (1970) changes the focus to acquisition of semantic functions as manifested in syntactic structures. Other researchers have examined the acquisition of language in the school-age child and have found, as Chomsky (1969) reports, that language is still undergoing development well into the school years.

Language, however, involves more than just a grammar or symbolic system. To examine only the syntactic or even the semantic aspect of language can give a distorted picture of the acquisition process. As the acquisition of language is analyzed more carefully, it may be possible to trace its development to organizing principles, precursors of language, that are largely nonlinguistic. Edmonds (1976, p. 194) points out, "each new skill or piece of linguistic knowledge appears to rest upon some previous skill or piece of knowledge which has its own developmental history." Evidence seems to indicate a predisposition in the human species to acquire language. However, to more clearly understand the nature of the language acquisition process, aspects of language organization in conjunction with the child's developing cognitive abilities gives insights into a developmental perspective larger than simply the acquisition of language structures apart from more inclusive organizing principles.

This paper investigates the aspects of language organization as manifested in writing ability in conjunction with the child's developing cognitive abilities, specifically the ability to formulate hypotheses. Cromer (1974, p. 246) argues

that humans "are able to understand and productively to use particular linquistic structures only when cognitive abilities enable them to do so."

That language acquisition and cognitive development are integrally related processes is generally acknowledged. Studies by Ferreiro and Sinclair (1971), for example, give empirical evidence that performance of certain linguistic operations is closely associated with certain cognitive functions. However, the precise relationship between the processes of language and cognitive development is yet to be clearly established. Piaget's framework for intellectual development gives a basis for examining some of these critical relationships. Tremaine (1975) has demonstrated that the comprehension of syntactic structures in bilingual children is closely correlated with the Piagetian stages of operational thought. She sees a relationship between the twin processes of assimilation and accomodation in language acquisition strategies. Assimilation, the process by which the child integrates objects and events into already established conceptual structures is balanced with accommodation, the alternation of established organization to incorporate new structures. Equilibration is a dynamic balance between assimilation and accomodation. Acquisition of new structures into the language system, then, must take into account these paired processes.

To understand the language acquisition process itself, however, one must be one step removed from these processes defined in Piagetian terms to an earlier process involving hypothesis formation, testing, and evaluating. Before attempting assimilation of new language structures, the child first hypothesizes about the type of structure utilized in the grammar under construction, a set of internalized rules, and then tests these hypotheses for communicative ability, followed by acceptance or rejection of the hypotheses. This, of course, is a gradual process, taking the normal first-language learner many years to complete. In fact, early studies that have claimed the process of first language acquisition is completed by approximately age 5 have been challenged by those done by

Chomsky (1969) working with school-age children who were monolingual speakers of English and Kessler (1971) investigating the acquisition of language in primary grade bilingual children. Theirs, together with other studies, have concluded that the process of language acquisition continues well into the school years and that the final cut-off age remains unknown.

That language acquisition is still developemental well into the school years is well demonstrated in the research reports on the acquisition of language as manifested in writing skills by children at various grade levels. Hunt (1965, 1970), O'Donnell, Griffin, and Norris (1967), Loban (1970) and Braun and Klassen (1973) found that children's written language correlated in syntactic complexity with age. Richardson et al (1976) found that 11-year-old children compacted more ideas into a single sentence by the process of embedding one sentence in another than did younger children. Furthermore, some of these studies together with others found that written syntactic development continues well into adolescence and beyond.

Looking more closely at written language, some investigators have examined the effect of social class on language acquisition. Results appear non-conclusive. Calvert (1972) reports a high correlation between social class and syntactic complexity in children's writing. Bruininks (1970) found that children from a middle class socio-economic group did better than those from a low socio-economic level on written language tasks. On the other hand, Mason (1968) found that social class was not a significant variable in children's creative writing ability.

The purpose of this paper is to examine the interlocked relationships between cognitive development, language acquisition, and socio-economic class as manifested in children's written language. Few studies have examined the interrelationship between all three sets of variables.

Quinn (1971, 1975) has demonstrated that children can be taught to form

hypotheses of increasingly high quality. A follow-up study by Quinn and Kessler (1976) using written data from sixth grade children at an upper middle class socio-economic level showed that a high positive correlation exists between the quality of hypotheses generated in solving science problems and the syntactic complexity of the language used to express those hypotheses. In other words, the psycholinguistic abilities of children as reflected in the syntactic complexity of written language is positively affected by instruction in the formulation of scientific hypotheses. A study by Wright (1977) indicates that intensive instruction in the generation of hypotheses has long term effects. We can, therefore, assume that the positive effects on language development also persist.

The present investigation focuses on the socio-economic variable. The research question asked is if the positive correlation between the results of direct instruction in hypothesis formation on written language complexity observed for an upper socio-economic group of sixth grade children is generalizable over differing socio-economic levels. Is the socio-economic level of the child a variable in the psycholinguistic ability to produce increasingly complex language structures when the child learns to formulate scientific hypotheses of increasingly high quality?

In examining the interrelationships between cognitive development, language acquisition, and socio-economic class of the learner, this study also examines correlations of these three variables with IQ, reading scores, and overall grade-point average of the child.

2.0 Methodology

Four intact sixth grade classes participated in the study, one control and one experimental group from each of two socio-economic levels. Two groups, one control and one treatment group, consisted of classes of 50 students each in a low socio-economic urban area of Philadelphia, Pennsylvania. (Socio-economic Level 1). The upper socio-economic group (Socio-economic Level 2) was made up

of a control and treatment group, 32 students in each, from an upper middle class suburban area of Philadelphia.

The treatment consisted of 12 science inquiry film sessions and 6 discussion sessions, each session 40 minutes in length. The problem-presentation sessions were based on film loops of the Inquiry Development Program in Physical Science developed by Suchman (1962). Each 3-minute film loop depicts a single physical science problem. At the end of each science inquiry film session the students wrote as many hypotheses as they could in a rigorously controlled 12-minute period. The collected papers were then scored on two criteria: The Hypothesis Quality Scale developed by Quinn (1971) and the Syntactic Complexity Formula developed by Botel, Dawkins and Granowsky (1973).

2.1 Measures Used

To determine the construct validity of the Hypothesis Quality Scale, a set of 50 hypotheses taken from those written by the sixth grade children in the study were given to three science educators who assigned scores using Quinn's scale. The Nash-Beyers (Winer, 1962) computer program for inter-judge reliability gave an unadjusted reliability coefficient of 0.94, establishing the reliability of the scale. The Hypothesis Quality Scale rates hypotheses generated on a scale of 0 to 5.

The Botel-Dawkins-Granowsky measure of syntactic complexity was selected from among others because of the theoretical basis on which it was established and because of the ease with which it can be used by the nonlinguist. In a critique of indices of syntactic maturity, O'Donnell (1976) suggests a fine balance between precision and utility for complexity measures. One problem in determining the syntactic complexity of children's structures lies in the fact that indices based on mean length of syntactic units do not, in reality, give evidence of the complex strategies that can be employed in achieving

length or syntactic density. For purposes of this study, the Botel-Dawkins-Granowsky index of syntactic complexity appears to meet the criterion of adequate precision while at the same time presenting a high degree of applicability.

The formula is derived from transformational-generative grammar theory, taking into account language development and performance studies which consider the frequency of usage of structures in children's oral and written language as well as experimental data on children's processing of syntactic structures. In applying the formula, syntactic structures are assigned weighted scores ranging from 0 to 3. One significant feature of the Botel-Dawkins-Granowsky formula is that syntactic maturity or complexity is a function of specific structures rather than sentence length.

2.2 Procedures

Following each set of two film sessions, one of the investigators conducted a discussion session which focused on teaching the children how to formulate good hypotheses. During these sessions, the investigator interacted with the children by asking what they observed, inferred, and what changes in physical conditions took place during the film. Both statements given orally by the children and some of the hypotheses they had written during the film sessions were written on the blackboard. The investigator then applied the Hypothesis Quality Scale as a criterion to these statements to show the children how to judge their own hypotheses and how to make use of their observations and inferences to generate hypotheses of higher quality. Children in the treatment group consequently learned to distinguish between a 0-value hypothesis as 'Magic did it' and a 5-value one, as 'I could test my idea by puting several little bottles with different amounts of water in them in a tub and seeing which ones would sink.'

At the end of the treatment, three additional film sessions were presented

to the control group to elicit hypotheses for the criterion variable for that group. The hypotheses generated under these conditions provide the raw data for the present study.

3.0 Results

Means and standard deviations for the five variables considered for the control and treatment groups of both the upper and lower socio-economic groups are given in Tables 1 and 2.

INSERT TABLE 1

IQ was measured by Otis Quick-Scoring Mental Ability Test, Beta, Form FM; and reading scores by Part III of the Pupil Progress Series, Diagnostic Reading Test.

Closely matched for IQ, reading comprehension, and grade-point average, the treatment and control groups of the upper socio-economic groups demonstrate marked differences in hypothesis quality and written language complexity. The group given instruction in science problem-solving situations scored considerably higher than the control group in the quality of their hypotheses and the complexity of the written language used to express those hypotheses.

INSERT TABLE 2

Also matched for IQ, reading comprehension, and grade-point average, although all three variables are somewhat below those of the upper socio-economic group, the treatment and control groups for the lower socio-economic groups also demonstrate considerable gains in the quality of hypotheses formulated and in the complexity of the written language used to express them.

Correlation matrices examine the relationship between the quality of hypothesis scores (HYPO), the level of syntactic complexity of the hypotheses (LANG) and the additional variables of reading comprehension (READ), IQ, and grade-point average (GRA). Table 3 gives correlations for the upper socio-economic control group.

INSERT TABLE 3

Hypothesis quality and syntactic complexity of language correlate more positively with each other than with any of the other three variables: reading, IQ, and grade-point average. In other words, the ability to formulate scientific hypotheses and the level of language complexity utilized in their expression apparently involve some of the same underlying processes. In turn these differ, at least in some respects, from those measured by IQ tests, reading comprehension tests and overall grade-point average. Table 4 gives the correlation matrix for the treatment group of the upper socio-economic group.

INSERT TABLE 4

It can be observed from Table 4 that the highest positive correlation also is found between hypothesis quality and language development rather than with any of the other three variables. More specifically, as children learn to formulate better hypotheses, the level of language development increases. The slightly lower Pearson product moment correlation coefficient for the treatment group is undoubtedly attributable to the scoring procedures used in determining hypothesis quality and syntactic complexity. The scores of 0 through 5 for the Hypothesis Quality Scale are not equal interval scores; the scoring procedure for syntactic complexity allows a single hypothesis to receive multiple scores. In

spite of the procedural differences in calculating hypothesis quality and syntactic complexity, a positive correlation is evident.

Table 5 gives the correlation matrix for the lower socio-economic control group.

INSERT TABLE 5

Just as for the upper socio-economic group, it can be observed that the highest positive correlation occurs between the two variables of hypothesis quality and language development rather than with reading comprehension, IQ, or grade-point average. Table 6 presents correlations for the lower socio-economic treatment group.

INSERT TABLE 6

The lower socio-economic treatment group, just as the control group, shows the highest positive correlations for hypothesis quality and language development rather than with reading comprehension, IQ, or grade-point average. In other words, the pattern observed for the upper socio-economic group is maintained for the lower socio-economic group.

Table 7 combines both economic groups in examining the level of significance for correlation coefficients between hypothesis quality scores and those measuring levels of syntactic complexity.

INSERT TABLE 7

With the level of significance of correlation coefficients for hypothesis quality with syntactic complexity at 0.001 for control and treatment groups at

both the upper and lower socio-economic levels, it becomes evident that the quality of scientific hypotheses generated in problem-solving situations is highly correlated with the complexity of the language used in expressing those hypotheses.

Figure 1 summarizes the findings of this study for the relationship between gains made in hypothesis quality scores and those for written language syntactic complexity for the control and treatment groups of the two socio-economic levels.

INSERT FIGURE 1

The treatment groups at both the upper and lower socio-economic levels obtained consistently higher hypothesis quality scores and syntactic complexity scores than did the control groups at the two levels. On both measures the upper socio-economic group starts at a slightly higher level than does the lower socio-economic one. However, the crucial aspect is that both groups show positive gains in the quality of hypotheses generated and in the complexity of the written language used to express the hypotheses.

4.0 Conclusions and Implications

Results of this study indicate that socio-economic level of the child is not a variable in the relationship between the psycholinguistic ability to produce complex syntactic structures and the cognitive ability to formulate scientific hypotheses. Scores for hypothesis quality and syntactic complexity for control and treatment groups at each of two socio-economic levels show a high positive correlation between the two measures. Differences occur not so much between socio-economic levels but rather between control and treatment groups at both levels. The complexity of the language used to express hypotheses and the quality of those hypotheses were consistently higher for groups given instruc-

tion in the formation of hypotheses.

Hypothesis formation is a basic inquiry skill. Findings from this study support the concept that hypothesis formation and language development are logically related, that both are tapping underlying cognitive principles of organization available to all normal human individuals. Although there was some difference in the quality of hypotheses and written language complexity at the onset of direct instruction of the treatment groups at two socio-economic levels, both groups made marked gains on both variables. Any differences between the two groups are offset by the dramatic rise in the ability to formulate scientific hypotheses and express them in complex language structures.

In the Piagetian sense, one may view instruction in the generation of hypotheses as an attempt to help the learner move to a higher cognitive level of inquiry. Although researchers have often noted the close relationship between cognitive and linguistic development, few have analyzed the direct relationship between specific cognitive processes, as hypothesis formation, and language acquisition. This study suggests a facilitating interaction between the ability to hypothesize and the level of language development of the child. Furthermore, this interaction is generalizable across socio-economic boundaries. Evidence is given here that the ability to formulate hypotheses is a variable which influences language development. In addition, neither of these variables is directly related to measurements of IQ or reading ability as determined by standardized tests. This argues that the indices used in measuring the quality of hypotheses the children generated and the syntactic complexity of their written language were assessing interrelated or similar underlying organizing principles in the brain.

Apart from the theoretical implications of this study for developmental psychologists and psycholinguists, results have relevance for educators regardless of the socio-economic level of the children with whom they are

working. The teacher as facilitator in the child's intellectual growth to higher levels of thought and more advanced stages of language development is needed for both the upper socio-economic suburban educational setting and the lower inner-city environment.

Furthermore, findings have implications not only for monolingual children acquiring their first language, but for bilingual children or those acquiring a second language as well. High positive correlations between hypothesis quality and language development such as those obtained in this study, regardless of the socio-economic level of the children, may also be expected in a bilingual situation in which two languages are under development. Experimental evidence as that reported in Cohen (1975) for the Redwood City Bilingual Project for Mexican-Americans shows that children in the bilingual treatment group appear to have developed nonverbal reasoning powers to a degree significantly higher than those of the control group. If one were to use the type of problem-solving situations presented to the sixth graders in this study from a bilingual approach, one could expect an increase in the quality of hypotheses generated in two languages. This cognitive development would then, in theory, be reflected in the complexity of the language used to express those hypotheses in either language. Clearly, there is a need for extensive research in this area.

A basic premise, however, underlying most of the recent research on child second language acquisition views cognitive structure as playing a major role in the way the child learns a second language. Cook (1969), Ervin-Tripp (1974) and others have pointed out that the second language acquisition process may be closely similar to first language development. As Dulay and Burt (1976) have explained in their extensive research on child second language acquisition, children learn language through a creative construction process, using certain strategies to organize the linguistic input, developing and testing hypotheses

on how the language operates. This natural process is facilitated when the child has the opportunity for direct interaction with the physical and social environment. Focus in the communication situation is on the ideas or meaning being conveyed, not on the form or structure needed to express the meaning. A productive natural communication situation is one which provides the child with an opportunity to activate the language learning process. Visually demonstrable problems such as those presented in the science lessons used in this study arouse interest, create a meaningful situation, and challenge cognitive processes which in turn may trigger the Piagetian-defined strategies of assimilation and accommodation. Re-organization of cognitive structures should lead in turn to re-organization of language structures and increased development of both. Bilingual education, then, has the potential for expanding cognitive abilities as well as language abilities.

In the Edgewood Independent School District of San Antonio, Texas, we have developed a set of guidelines for bilingual instruction in science and social studies inquiry experiences through the NIE-supported Experimental School Plan. From the findings of the study reported in this paper it is our prediction that implementation of a bilingual program of this type will facilitate the acquisition of two languages, in this case Spanish and English, for children from a low socio-economic group. The Edgewood School Plan, as the NIE project is termed, is concerned with bilingual education of Mexican-American children who are in various stages of development for the first and second languages. The effects of an inquiry approach to instruction on language development, regardless of socio-economic level, as we have reported in this paper give evidence that this type of curriculum in bilingual education programs can play a central role in the cognitive and language development of the participants, both in regard to the first language as well as the second.

In summary, the findings of this study corroborate other investigations that show a positive correlation between cognitive and language development. However, findings in this report specifically identify the correlation between the ability to generate hypotheses and the level of language development as measured in terms of syntactic complexity. This correlation is independent of socio-economic variables, indicating that this is a generalized principle operating for all children. And, finally, this principle may be expected to apply in any type of language acquisition situation, either first or second.

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APPENDIX

TABLE 1

MEANS AND STANDARD DEVIATIONS
UPPER SOCIO-ECONOMIC GROUP

VARIABLE	CONTROL MEAN	CONTROL SD	TREATMENT MEAN	TREATMENT SD
HYPOTHESIS QUALITY	25.4	11.4	53.3	21.5
WRITTEN LANGUAGE COMPLEXITY	52.6	25.4	130.0	43.5
INTELLIGENCE QUOTIENT	108.9	21.7	110.7	10.8
READING	67.2	15.8	70.1	12.0
GRADE-POINT AVERAGE	79.2	15.5	80.2	6.1

TABLE 2

MEANS AND STANDARD DEVIATIONS
LOWER SOCIO-ECONOMIC GROUP

VARIABLE	CONTROL		TREATMENT	
	MEAN	SD	MEAN	SD
HYPOTHESIS QUALITY	15.7	8.7	42.8	23.5
WRITTEN LANGUAGE COMPLEXITY	36.3	15.2	83.2	41.6
INTELLIGENCE QUOTIENT	101.2	9.4	103.1	11.7
READING	57.7	15.4	57.8	14.9
GRADE-POINT AVERAGE	77.0	8.5	77.8	7.8

TABLE 3

CORRELATION MATRIX FOR THE CONTROL GROUP
UPPER SOCIO-ECONOMIC GROUP

	HYPO	LANG	READ	IQ	GPA
HYPO	1.00	0.87	0.62	0.57	0.53
LANG		1.00	0.55	0.51	0.52
READ			1.00	0.88	0.89
IQ				1.00	0.95
GPA					1.00

TABLE 4

CORRELATION MATRIX FOR THE TREATMENT GROUP
UPPER SOCIO-ECONOMIC GROUP

	HYPO	LANG	READ	IQ	GPA
HYPO	1.00	0.71	0.44	0.51	0.65
LANG		1.00	0.57	0.53	0.68
READ			1.00	0.74	0.70
IQ				1.00	0.84
GPA					1.00

TABLE 5

CORRELATION MATRIX FOR THE CONTROL GROUP
LOWER SOCIO-ECONOMIC GROUP

	HYPO	LANG	READ	IQ	GPA
HYPO	1.00	0.60	0.28	0.22	0.44
LANG		1.00	0.25	0.10	0.44
READ			1.00	0.67	0.75
IQ				1.00	0.70
GPA					1.00

TABLE 6

CORRELATION MATRIX FOR THE TREATMENT GROUP
LOWER SOCIO-ECONOMIC GROUP

	HYPO	LANG	READ	IQ	GPA
HYPO	1.00	0.65	0.46	0.44	0.59
LANG		1.00	0.38	0.28	0.57
READ			1.00	0.77	0.69
IQ				1.00	0.76
GPA					1.00

TABLE 7

LEVEL OF SIGNIFICANCE FOR CORRELATION COEFFICIENTS

	Upper SE		Lower SE	
Variables	Control	Treatment	Control	Treatment
HYPOTHESIS WITH LANGUAGE	0.001	0.001	0.001	0.001

FIGURE 1

COMPARISON OF GAINS IN HYPOTHESIS QUALITY AND WRITTEN LANGUAGE FOR TWO SOCIOECONOMIC GROUPS